JIUN MASUDA
CONSULTING ENGINEER
MARUNOUCHI, TOKIO

MADE BY J. Masuda DATE 15-3-12 FILE NO
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CALCULATIONS FOR

Sobunkei Bridge.

We are requested from Mr. D. Kuroita of Ishikjima Machinery Works of Tokyo, to prepare most economical design of the bridge which bid is invited with competitive plan of Bridge maker.

General Data are given in the specification and drawings

The roadway 24'0" wide lies to ins of handrails with earth fill on 6" Reinforced Concrete slab, handrails will be of structural steel or cast iron and the size of flume 10'-8" under the roadway between trusses.

Centre to centre of Piers = 123'-8" Height between top of pier and longitudinal stringer is limited to 19'-3" on the drawing furnished by the Company which is rather shallow for the loadings given for this bridge, to my opinion. Economical design from the given data is to make the truss height as high as possible even sacrificing the other minor details.

Let us proceed the design from the specification and given data.

Span length assumed as 120'-0" between c.to c of 2nd bearings leaving the space of 3'-8" on pier. Truss centers assumed 13'-6" to allow the shoes on pier and to give enough clearance between trusses and sides of water flume.

Highway slab.

Try 3'-0" spacing of stringers as given in the specification.

Dead Load.

Earth fill at crown	9½" @ 10#	=	95#
6" Concrete slab.		=	75
			170# per sq ft.

Dead Load moment = $\frac{1}{10} \cdot 170 \cdot 3^2$ = 153 ft#

Dead Load shear = $\frac{1}{2} \cdot 170 \cdot 3$ = 255#

Live Load motor truck loading

Rear wheel	9000#	Front wheel	3000
Impact 25%	2250		750
	11250#		3750#

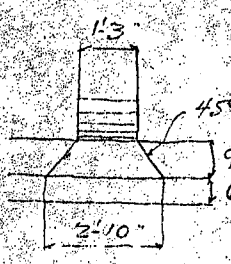
Distribution of wheel concentration. —

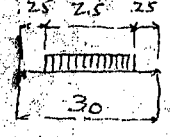
½ effective width = ⅔ span length + distribution of load on slab = 6

Assume this distribution 2'-6" = 6

Effective width = ⅔ · 3 + 2.5 = 4.5'

Load per ft strip 11250 ÷ 4.5 = 2500#





Moment at centre

1250 · 1.5 = 1875

1250 · $\frac{1.25}{2}$ = − 780

1095

For continuity of slab 1095 · 0.8 = 875 ft#

Shear say 2500 · $\frac{175}{300}$ = 1460#

Summary for moments and shears

	Moments	Shear
Dead Load	153	255
Live Load	875	1460
	1028 ft#	1715#

Effective depth of slab required for 600#/□" concrete stress and 15000#/□" steel stress.

$d = \sqrt{\frac{1028}{90}} = 3.38'$.

Thickness of slab used = 6" over all.

Try 4'-0" Spacing of stringers

Dead Load moment = $\frac{1}{10} \cdot 170 \cdot 4^2$ = 272 ft#

Dead Load shear = $\frac{1}{2} \cdot 170 \cdot 4$ = 340#

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CALCULATIONS FOR

Sobunkei Bridge

Live load motor truck loading

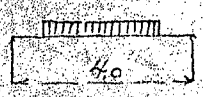
Effective width $\frac{2}{3}l + b = \frac{2}{3} \cdot 4 + 2.5 = 5.17'$

Load per ft strip $11250 \div 5.17 = 2180^{\#}$

Moment at centre $1090 \cdot \frac{4.0}{2} = 2180$

$1090 \cdot \frac{1.25}{2} = -680$

$1500^{\#}$



For continuity of slab $1500 \cdot 0.8 = 1200^{\#}$

Shear $= 2180 \cdot \frac{2.75}{4.00} = 1500^{\#}$ approx

Summary for moment and shear

	Moment	Shear
Dead Load	272	340
Live Load	1200	1500
	1472 #	1840 #

Effective depth of slab $= \sqrt{\frac{1472}{90}} = 4.05"$

Slab thickness 6" Effective depth say 5"

For shear $\frac{1840}{\frac{7}{8} \cdot 12 \cdot 5} = 35^{\#}/0"$ ok

Steel Area $= \frac{1472 \cdot 12}{\frac{7}{8} \cdot 5 \cdot 15000} = 0.270"$ per ft strip

For 5'0" stringer spacing

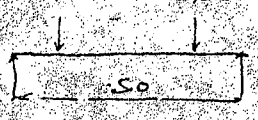
Dead Load moment $= \frac{1}{10} \cdot 170 \cdot 5^2 = 425^{\#}$

Dead Load shear $= \frac{1}{2} \cdot 170 \cdot 5 = 425^{\#}$

Live Load motor truck loading

Effective width $\frac{2}{3}l + b = \frac{2}{3} \cdot 5 + 2.5 = 5.83'$

Load per ft strip $11250 \div 5.83 = 1930^{\#}$



Moment $= 1930 \cdot 1.0 = 1930^{\#}$

For continuity of slab $1930 \cdot 0.8 = 1545^{\#}$

Shear say $1930^{\#}$

If assume the loads distributed over entire span

$3860 \div 5 = 772^{\#}$ per lin. ft $M = \frac{1}{10} \cdot 772 \cdot 5^2 = 1930^{\#}$

Summary for moment and shear

	Moment	Shear
Dead Load	425	425
Live Load	1930	1930
	2355 #	2355 #

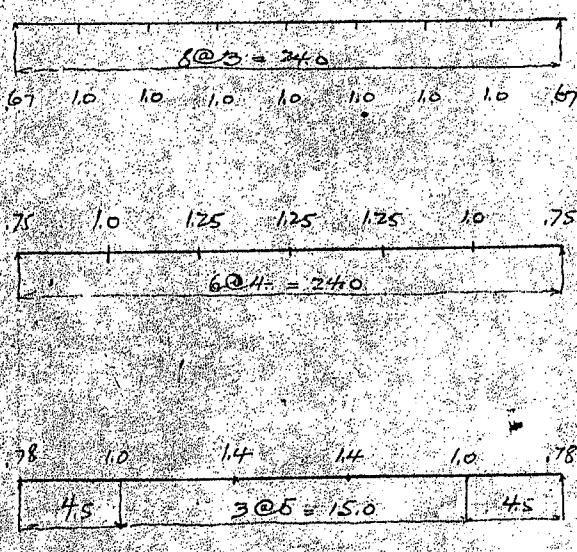
Effective $D = \sqrt{\frac{2355}{90}} = 5.11"$ insulation = .89"

Steel Area $= \frac{2355 \cdot 12}{\frac{7}{8} \cdot 5.11 \cdot 15000} = .4210"$ per ft

Shear $= \frac{2355}{\frac{7}{8} \cdot 5.11 \cdot 12} = 44^{\#}/0"$

From the calculations made above 6" slab is strong enough to carry the said live load up to 5'0" in span length.

Selection of Economical spacing of Stringers



Let us try 4.0 and 5.0 spacing for 10 and 12' span length of stringer.

Wheel load spacing assumed as follows.



Max Reaction on Stringer as given on Sketch

For 3.0 spacing $7 @ 1.0 = 7.00$, $2 @ .67 = 1.33$ — 8.33 wheels.

For 4.0 spacing $5 @ 1.25 = 6.25$, $2 @ .75 = 1.50$ — 7.75 wheels

For 5.0 spacing $4 @ 1.4 = 5.60$, $2 @ .78 = 1.56$ — 7.16 wheels.

From above comparison longer span length of slab give less weight of Stringer

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CALCULATIONS FOR

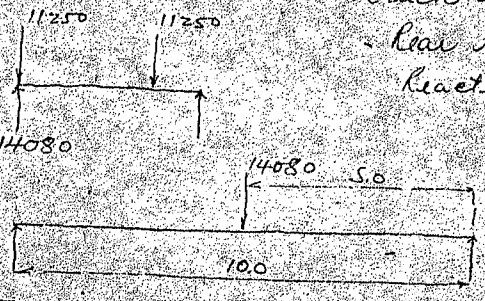
Sobunkei Bridge

Stringer span length 10'-0" spacing 4'-0"

Dead Load 170 · 4.0 = 680 #
Stringer 35
715 #

moment = 1/8 · 715 · 10² = 8950 ft#
shear = 1/2 · 715 · 10 = 3570 #

Live Load motor truck loading



Rear wheel Cone with impact = 11250#
Reaction = 11250 · 1.25 = 14080
moment at center = 7040 · 5.0 = 35200 ft#
Live Load & Shear say 14080

Summary for moment and shear

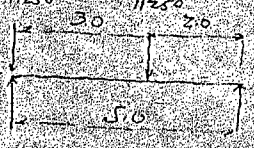
	moment	shear
Dead Load	8950	3570
Live Load	35200	14080
	44150 ft#	17650 #

Section modulus rqd = 44150 × 12 / 15000 = 35.3 12" · 5" @ 31.99# I Sm = 36.6

Stringer Span length 10'-0" spacing 5'-0"
Dead Load 170 · 5.0 = 850
45
895

moment = 1/8 · 895 · 10² = 11200 ft#
shear = 1/2 · 895 · 10 = 4475 #

Live load motor truck loading



Reaction on stringer = 11250 · 1.4 = 15750#
moment at center 15750/2 · 5 = 39400 ft#
shear = 15750

Summary for moment and shear

	moment	shear
Dead Load	11200	4475
Live load	39400	15750
	50600 ft#	20225 #

Section modulus rqd 50600 · 12 / 15000 = 40.5

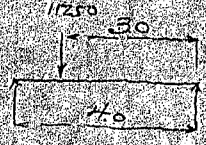
12" · 6" @ 44.2# I Sm = 52.51

From above investigation 10'-0" span 4.0 spacing is most economical for stringers.

Fascia Stringer span length 10'-0"
Dead Load say 6½" fill say 65#
Concrete 75#
140 · 2 = 280 #
Extra wt of Coping say 40#
Handrails say 45
365
Stringer say 30
395 # per lin ft

Dead Load moment = 1/8 · 395 · 10² = 4940 ft#
" " shear = 1/2 · 395 · 10 = 1975 #

Live load motor truck loading



rear wheel = 11250#
Reaction 11250 · .75 = 8430#
moment at center = 4215 · 5.0 = 21100 ft#
End shear = 8430 #

Summary for moment and shear

	moment	shear
Dead Load	4940	1975
Live Load	21100	8430
	26040 ft#	10405 #

Section modulus rqd 26040 × 12 / 15000 = 20.8

Use 10 · 3½" @ 23.55# I Sm 20.52

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CALCULATIONS FOR

Sobenkei Bridge

Stringer next to Fascia beam

Dead Load Earth fill average say 8" @ 10" = 80
6" concrete " " 75
155 × 4 = 620
wt of stringer 26
646

Dead Load Moment = $\frac{1}{8} \cdot 646 \cdot 10^2 = 8075^{\#}$
" Shear = $\frac{1}{2} \cdot 646 \cdot 10 = 3230^{\#}$

Live Load motor truck loading 1 rear wheel on center
moment at center = $\frac{11250}{2} \cdot 5.0 = 28100^{\#}$
Live Load Shear = $11250^{\#}$

Summary for Dead and L.L moment and shear

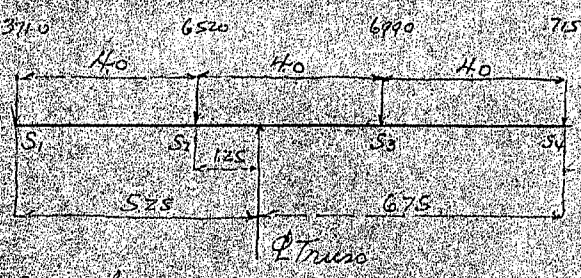
	Moment	Shear
Dead Load	8075	3230
Live Load	28100	11250
	36175#	14480#

Section mod reqd $\frac{36175 \times 12}{15000} = 28.9$

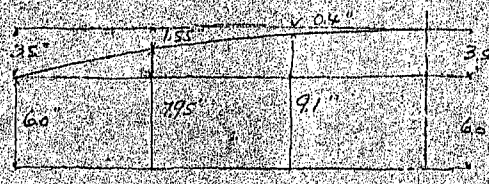
Use 10" 35# @ 29.99" I Sm = 29.14

Cantilever Bracket Spacing 10-0"
Overhanging arms beyond center line of Trucs
24'-0" − 13'-6" = 5.25'

Dead Load Concentration on Stringer



Thickness of Earth filling at panel point



Dead Load:

S4 95 @ 10" = 95"
Slab 75
170"/0'

Concentration S4 170 × 4 = 680
Stringer 35
715"

Concentration S2 155 × 4 = 620
Stringer 32
652"

S3 Earth fill 9.1" @ 100" = 91
Concrete slab 75
166"

Concentration S3 166 × 4 = 664"
Stringer 35
699 say 700"

S2 Earth fill 7.95 say 80"
Concrete slab 75
155"

Concentration S1 Earth fill 6" 60"
Concrete 75"
135 × 2 = 270"
Extra weight of Concrete say 30
Handrail say 45
1 Stringer say 26
371#

Summary for
Roadway slab pavement and handrail

1 @ S4	680	680
2 @ S3	664	1328
2 @ S2	652	1304
2 @ S1	371	742
		4054#

Reaction on Truss

S1	3710
S2	6520
S3	6990
½ S4	3575
	20795 call this 20800#

Dead Load Moment

Moment at S2 3710 · 4.0 = 14840# neg
Moment at ℄ Truss 3710 · 5.25 = 19500
6520 · 1.25 = 8150
− 27650# neg

Moment at S4
6990 · 4.0 = 28000
6520 · 8.0 = 52100
3710 · 12.0 = 44500
− 124600
20800 · 6.75 = + 140300
15700#
Pos Moment

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CALCULATIONS FOR

Sobinkei - Bridge

Cantilever Bracket and Floor Beam

Dead Load moment = 27650 ″ at ℄ of Truss Shear Floor Beam 20500 − 10230 = 10570
″ ″ shear = 10230 ″
Dead Load Beam say 60″ per lin ft assumed
moment at ℄ of Truss = 60 · $\frac{5.25^2}{2}$ = −826 ″ Shear 60″ · 525 = 315 ″
moment at ℄ of Bridge 60 · $\frac{12^2}{2}$ = −4320 Shear 720 − 315 = 405 ″
720 · 6.75 = + 4860
+ 540 ″

60″ per ft
5.25 — 6.75
60 · 12 = 720″

Summary for moment and shear

	℄ Truss moment	shear	℄ Bridge moment	shear
Dead Load Floor	−27650	10230	+ 15700	10570
″ ″ Beam	− 826	315	+ 540	405
	−28476 ″	10545 ″	16240 ″	10975 ″

Live load moment for Cantilever Bracket 11250 · .75 = 8450
11250 · .25 = 2800 say
11250 · $\frac{2.1}{4}$ = 3100 ″

11250″ 5.9 11250 #1
.40 4.25
8450 2800 3100 5900

moment at ℄ truss 8450 · 5.25 = 44200
5900 · 1.25 = 7370
51570 ″

Shear at ℄ Truss 8450
5900
14350 ″

Max Live load moment at ℄ of Floor Beam

11250 11250 11250 11250
0.6 5.9 3.0 5.9 0.6
S2 S3 S4
1.25 6.75 6.75 1.25
9560 4220 7030 7030
1690 7030 14060
5910 14060
Reaction 12940 ″
9560
22500 ″

Reactions on Stringers
11250 · $\frac{1.5}{4.0}$ = 4220 ″
11250 − 4220 = 7030 ″
11250 · $\frac{0.6}{4.0}$ = 1690 ″
11250 − 1690 = 9560 ″

moment at S4 5910 · 4.0 = 23640
9560 · 8.0 = 76400
−100040
22500 · 6.75 = + 152000
51960 ″

Max End shear 12940 for symmetrical loading

Load at S3 11250 · 10.75 =
11250 · 7.75 =
11250 · 1.85 =
11250 · 1.65 =
37.00 = 417000 ÷ 135 = 30850
− 11250
For max End shear 19600 ″

Summary for moments and shears

	Cantilever Bracket ℄ Truss moment	shear	Floor Beam ℄ Span moment	shear
Dead Load	− 28476	10545	+ 16240	10975
Live Load	− 51570	14350	+ 51960	19600
	−80046 ″	24895 ″	+ 68200 ″	30575 ″

Section of Cantilever Bracket
web assumed 21⅜ · ⅜ Effective depth 1′-7½″ = 1.62′
Stress in tension pl 80046 ÷ 1.62 = 49400 ″ Section req'd $\frac{49400}{15000}$ = 3.30 sq in

Use 7½ · ⅝ tension pl = 4.69 □″ gross or 3.44 □″ net For Compression flange use
21⅜ · ⅜ = 4960

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CALCULATIONS FOR

Sobunkei Bridge

For overhanging portion 2Ls 3.3.3/8 = 4.22 □" gross o.k.

Section of Floor Beam

web assumed 17.3/8 = 6.37 ⅛ web = 0.80 Effective depth = 1.46 - .14 = 1.32'

Stress 68200 ÷ 1.32 = 51600 # Section rigid 51600 ÷ 15000 = 3.44

8

2.624 □" net

Use 2Ls 3.3.3/8 . 4.22 □" gross or 3.46 □" net.

Unit shearing stress 30575 ÷ 6.37 = 4800 #/□"

Approximate weight of floor Beam and Pantilever Baskets.

Pantilever Baskets	4Ls 3.3.3/8	@ 7.2	. 4'-7"	=	132
"	4Ls 3.3.3/8	@ 7.2	. 5'-0"	=	144
"	2Pls 20½.3/8	@ 26.14	. 4'-9¾"	=	252
"	4Ls 4.3.3/8	@ 8.5	. 1'-5"	=	50
Floor Beam	2Ls 3.3.3/8	@ 7.2	. 4'-8"	=	168
"	1Pl. 17.3/8	@ 21.68	. 12'-1½	=	262
"	4Ls 4.3.3/8	@ 8.5	. 1'-4¼	=	46
"	2Ls 3.3.3/8	@ 7.2	. 12'-1½	=	175
"	4Ls 4.3.3/8	@ 8.5	. 1'-1½	=	38
Tension Rd.	2Pls 7½.3/8	@ 15.94	. 4'-6"	=	144
					1411

Rivet heads and variation say 3% 42

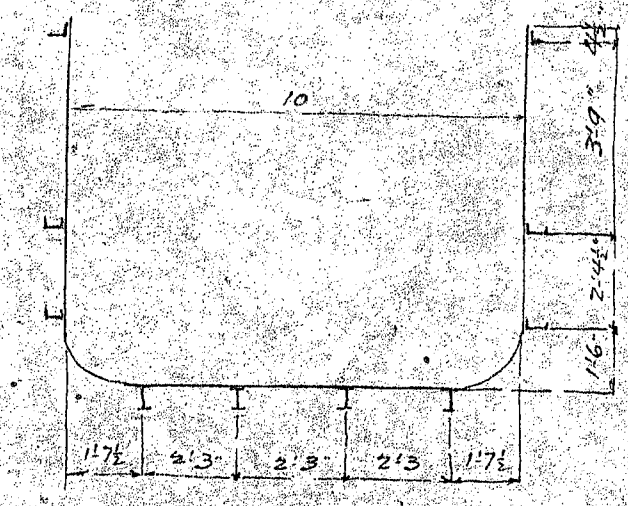
1453 #

1453 ÷ 24 = 60.5 # per lin ft of girder

or 1453 ÷ 10 = 145.3 # per lin ft of truss.

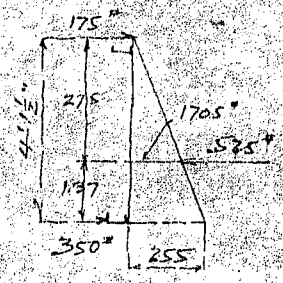
Design of water Flume.

Thickness of plate specified as 3/8"



Strength of flume Plate

Side wall



Total Pressure 255 . 4-12/2 = 525"

Reactions 175" at top and 350" at bottom

Moment

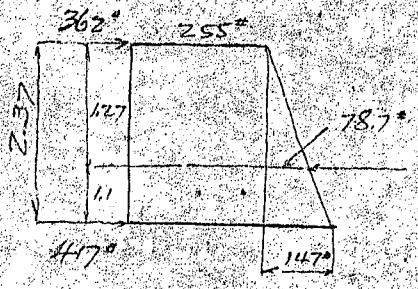
175 . 2.75 = 480.0

170.5/2 . 2.75 = 234 @ .915 = 214.0

266.0 in#

Fibre stress = 6 . 266 . 12 / 12 . .375² = 11320 #/□"

2nd Section



Centre of gravity of Pressure

255 . 2.37 = 605 . 1.18 = 714

147 . 2.37/2 = 174 . 0.79 = 137.5

779 1.10 851.5

Reactions 779 . 11/2.37 = 362"

779 - 362 = 417#

Moment 362 . 1.27 = 460

255 . 1.27 = 324 . 0.63 = 204

78.7/2 . 1.27 = 50 . 0.42 = 21

+225

235 in#

Fibre stress = 6 . 235 . 12 / 12 . .375² = 10.000 #/□" ok

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CALCULATIONS FOR

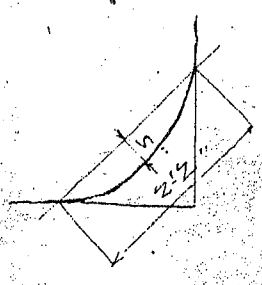
Sobunkei Bridge

Bottom plate of Flume

Load 8.0 · 62.0 = 496# per sq ft. Span length 2'3"

moment = 1/8 · 496 · 2.25² = 251.0 Fibre stress = $\frac{6 \cdot 2510 \cdot 12}{12 \cdot .375^2}$ = 10700 #/□" ok

Plate at corner.



Side pressure assumed uniform and taken as 496#/□'

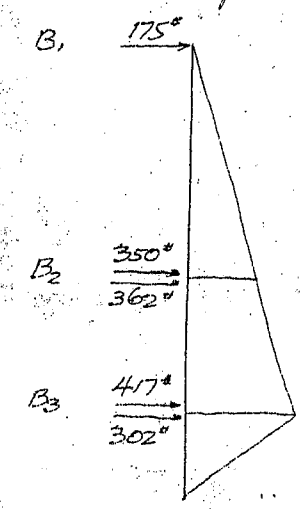
moment = 1/8 · 496 · 2.17² = 292.0"

Tensile stress in plate = $\frac{292}{.42}$ = 695 #

Unit stress = $\frac{695}{12 \cdot .375}$ = 155 #/□" ok.

This stress will be carried by bottom plate of flume and plate in the side wall.

Side Beam of Flume.



Reaction due to water pressure.

From calculation of side plate the reaction tabulated as shown on sketch

Pressure at the corner carried by tension side pressure and bottom pressure assumed as zero at bottom

pressure at B3 255 + 147 = 402# span assumed 1'6"

reaction on B3 $\frac{402}{2}$ · 1.5 = 302#

Beam B1 moment = 1/8 · 175 · 10² = 2190 "#

Section modulus reqd = $\frac{2190 \cdot 12}{15000}$ = 1.75

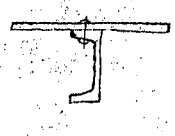
Use L 4.3.3/8" Sm = 1.50 with 3/8" plate evidently Ok.

Beam B2 and B3. span length 10'-0"

Pressure = 719# per lin. ft of span m = 1/8 · 719 · 10² = 9000 "#

Section modulus reqd = $\frac{9000 \cdot 12}{15000}$ = 7.20

Try 6"[12.04# with 3/8" plate. 6"·3/8" Plate assumed



6 · 3/8"	=	2.25 · 0.19	=	.43
6"[	=	3.54 · 0.338	=	11.97
		5.79 · 2.14		12.40

} Centr of gravity of section

Moment of inertia:

2.25	·	1.95²	=	8.55	8.55
3.54	·	1.24²	=	5.44 + 18.7	= 24.14
					32.69 (in)⁴

Section modulus = $\frac{32.69}{4.24}$ = 7.71 6"[@ 12.04# ok.

Bottom Beam

load. 496 · 2.25 = 1115#

beam say 30

1145#

moment = 1/8 · 1145 · 10² = 14340 "#

Section modulus = $\frac{14340 \cdot 12}{15000}$ = 11.45

Use 7"·4" @ 16.01# I Sm = 11.20

which will be all right combined with 3/8" bottom plate.

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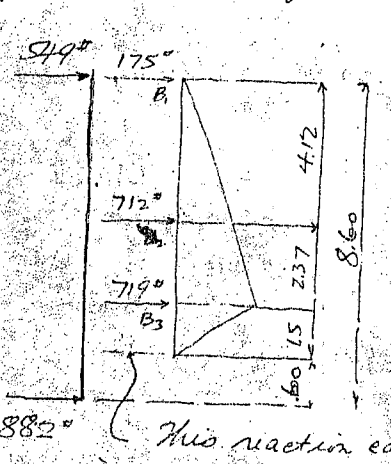
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CALCULATIONS FOR

Sobunkei Bridge

Side up-right for Flume.



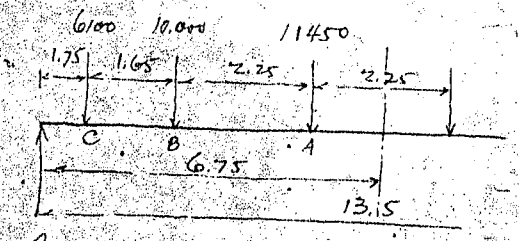
This reaction carried by bottom plate

Reaction
712 · 4.12 = 2930
719 · 6.50 = 4660
1431 7590 ÷ 8.60 = 882#
1431 - 882 = 549#

Moment at B2 549 · 4.12 = 2265 12
For 10.0' m = 22650 14
Section modulus rqd = 22650 · 12 / 15000 = 18.10

Use I 8"-5" @ 28.02# Sm = 22.34

Bottom Floor Beam.



R = 27550#

Moment 27550 · 6.75 = 186000
11450 · 1.12 = 12800
10000 · 3.37 = 33700
6100 · 5.0 = 30500
77000
109000 #
DL Beam 1/8 · 100 · 13.5² = 2270
111270 #

Concentration
A 496 · 2.25 = 1115
beam say 30
1145 · 10 = 11450#

B 496 · 1.95 = 970
beam 30
1000 · 10 = 10000#

C 496 · .82 = 410
metal say 200
610 · 10 = 6100#

Web assumed 18 · 3/8 = 6.75 3/8 web = 0.824.0"
Effective D = 1.40
Stress 111270 ÷ 14 = 79500#
Section rqd = 79500 ÷ 15000 = 5.30
824
4.460 rqd

2L 4x3x3/8" = 4.92.0" or 4.360" rqd OK

Approximate weight of Flume and details thereto.

Flume Plate	4 @ 60 · 3/8	@ 76.5	=	3060
" "	1Pl 6-7 · 3/8	@ 85.4	=	85.4
Side beams	2Ls 4 · 3 · 3/8	@ 8.5	=	170
" "	4Ls 6 x 2 1/2	@ 12.04	=	48.1
bottom beam	3I 7" · 4	@ 16.01	=	48.1
				504.6#
	Details say 7%			35.4
				540.0# per lin ft.
Side upright	2Is 8" · 5" @ 28.02	· 8.60	=	740
Floor Beam	4Ls 4.3.3/8 @ 8.5	· 12.5	=	425
	1Pl 18 · 3/8 @ 22.95	· 12.5	=	286
				1451#
	Details say 7%			100
				1551# ÷ 10 = 155# per lin ft.

Summary of weight:
Flume 540#
Upright + FB 155
695# per lin ft of span

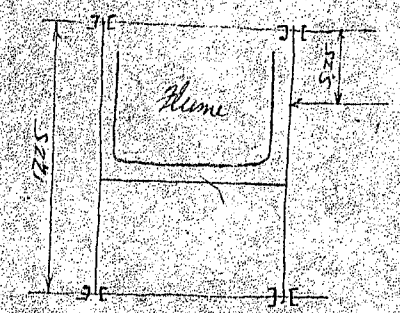
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CALCULATIONS FOR

Sobuntei Bridge.

Lateral System.

Wind pressure 60#/0' on flume 400# per lin ft on upper deck and 200# per lin ft on bottom chord



Total pressure on flume 8.0 · 60# = 480# per lin ft

Reaction on top chord = $480 \cdot \frac{12}{17.25} = 334$# per ft

Reaction on bottom chord = 480 − 334 = 146# per lin ft.

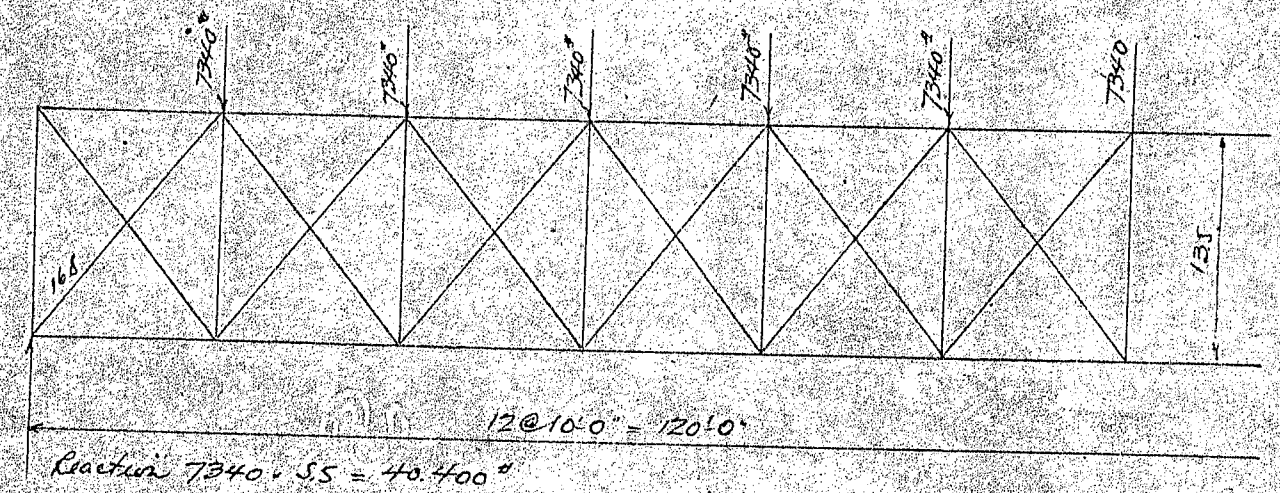
Summary of wind load

For upper chord 334 + 400 = 734# per ft

For Lower chord 146 + 200 = 346# per ft.

Upper Lateral Bracing

Concentration 734 × 10 = 7340# per panel point



Reaction 7340 · 5.5 = 40.400#

$\sec\theta = \frac{16.8}{13.5} = 1.244$

$\tan\theta = \frac{10.}{13.5} = 0.74$

$w \sec\theta = 7340 \cdot 1.244$
$= 9250$#

This bracing can be made stiff member using the connection to flange of Stringer. However to make rigid connection figure the bracing as tension member only and the stiff member will carry a part of wind stress as per rigidity of member which will add to the factor of safety.

Panel			Stress			90% acting against wind		Used section		
1	9250/12	· 66	= 50800#	÷ 15000	= 3.40" net	3.80" net	2L 3.3.3/8	= 4.22	9.0 R
2	"	· 55	= 42400	"	= 2.82	3.13 "	2L 3.3.3/8	= 4.22	8.0 R
3	"	· 45	= 34600	"	= 2.30	2.55 "	1L 5.3.3/8	= 2.86	6.4 R
4	"	· 36	= 27800	"	= 1.85	2.05 "	1L 5.3.3/8	= 2.86	5.3 R
5	"	· 28	= 21600	"	= 1.44	1.60 "	1L 3½.2½.3/8	= 2.11	4.0 R
6	"	· 21	= 16200	"	= 1.08	1.20 "	1L 3½.2½.3/8	= 2.11	4.0 R

Bottom Lateral Bracing Concentration 3460# $w \sec\theta$ = 3460 · 1244 = 4300#

Panel			Stress			75% effective			
1	4300/12	· 66	= 23600#	÷ 15000	= 1.57" net	2.05" net	1L 4.4.3/8	= 2.86	5 R
2		· 55	= 19700		= 1.31	1.74	1L 4.3.3/8	= 2.45	4 R
3		· 45	= 16100		= 1.07	1.42	1L 3½.2½.3/8	= 2.11	3 R
4		· 36	= 12900		= 0.86	1.14	do	= "	3 R
5		· 28	= 10000		= 0.66	0.88	do	= "	3 R
6		· 21	= 7500		= 0.50	0.67	do	= "	3 R

Cross strut for bottom chord

2L 4.3.3/8 = 4.960 r = 1.29

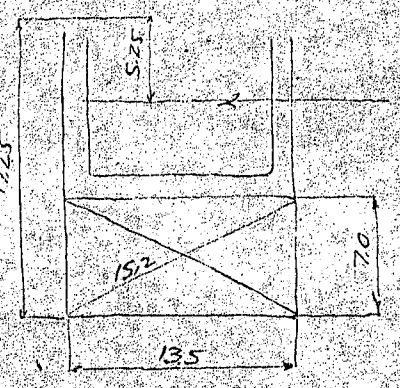
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CALCULATIONS FOR

Sobunkei - Bridge.
Cross Frame under water flume.
Intermediate Cross Frame.



Earthquake effect on floats in flume 4950# . 0.2 = 990#
Panel Concentration = 9900#
stress in diagonal acting as tension member only
$9900 \cdot \frac{15.2}{13.5} = 11150$ #/□" Section req'd = 0.743 □"

Use 1L 3½ . 2½ . 3/8 = 2.11 □" 75% Effective 1.580 □" = 1.20 □" net

Use 3 rivets for connection.

End Cross Frame. Entire horizontal load = 9900 . 6.8 = 61,100#
stress in diagonal = $61{,}100 \cdot \frac{15.2}{13.5} = 68{,}800$ #

Using stiff member for diagonal the stress in diagonal will be ½ of the stress figured above, that is 68800 ÷ 2 = 34400#
unsupported length in lateral - say 13.0 . 12 = 156"

⌊ 2Ls 5 . 3 . 3/8 r = 2.49 Unit stress = $15000 - 70 \cdot \frac{156}{2.49} = 10630$ #/□"
Section required = 34400 ÷ 10630 = 3.23 □"

⌊⌊ 2Ls 5 . 3 . 3/8 r = 1.74 Unit stress = $15000 - 70 \cdot \frac{156}{1.74} = 6200$ #/□"
Section required = 34400 ÷ 6200 = 5.54 □"

Use 2Ls 5 . 3 . 3/8" 3" leg outstanding.

Cross Strut at panel point Lo. 4Ls 3½ . 2½ . 3/8" laced 3½" leg outstanding $\frac{l}{r} = \frac{156}{1.45} = 107.5$

Approximate weight of Lateral Framing.

Top Laterals. 4Ls 3 . 3 . 3/8 @ 7.2 . 6'-9¾ = 196
2Ls 3 . 3 . 3/8 @ 7.2 . 14'-4½ = 208
Connection plate say 50
454 . 4 = 1820#

2Ls 5 . 3 . 3/8 @ 9.8 . 6'-9¾ = 132
1L 5 . 3 . 3/8 @ 9.8 . 14'-1½ = 138
Connection Ls and plate say 60
332 . 4 = 1328
332 . 2 = 664

2Ls 3½ . 2½ . 3/8 @ 7.2 . 6'-11" = 100
1L 3½ . 2½ . 3/8 @ 7.2 . 14'-2" = 102
Connection say 30
232 . 2 = 464
4270#
Rivet heads & variation say 124
4400#

4400 ÷ 120 = 37# per lin ft

Bottom Laterals. 2Ls 4 . 4 . 3/8 @ 9.8 . 14'-7½ = 286
Connection plate say 30
316 . 2 = 632#

2Ls 4 . 3 . 3/8 @ 8.5 . 14'-7½ = 248
connection plate say 22
270 . 2 = 540

2Ls 3½ . 2½ . 3/8 @ 7.2 . 14'-7½ = 210
Connection plate say 15
225 . 8 = 1800#

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CALCULATIONS FOR

Dobinkei Bridge

Cotton Laterals

Summary from above 2972 #
Rivet heads + variation say 98
3070 #

3070 ÷ 120 = 25.6# per lin ft

End Sway frame

	4Ls 5x3. 3/8 @ 9.8 . 12-2"	=	476
	4Ls 3½.2½.7/8 @ 7.2 . 11.5"	=	329
	Details say		120
		925 x 2 =	1850#
2nd Sway frame	2Ls 3½.2½.3/8 @ 7.2 . 13.0	=	188
	2Ls 4.3.3/8 @ 8.5 . 12.4"	=	210
	Details say		50
			448
	Rivet heads + variation say		17
	465 x 11	=	5115
			6965#

6965 ÷ 120 = 58.0# per lin ft.

Summary for Cotton Laterals and Sway frames

Cotton laterals	25.6
Sway frames	58.0
	83.6 call this 84# per lin ft

Weight of Stringers

3 @ 35#	=	105#
2 @ 32	=	64
2 @ 25	=	50
	219#	call this 220# per lin ft

Summary for Dead Load metal

Stringers	220# per lin ft
Floor Beams	145
Top Laterals	37
Cotton Laterals + Sways	84
water flume and adv details say	695
Trusses assumed	1295
	2476# per lin ft of span

Earth fill pavement	60#	.239	= 1195#
" " parabolic crown	⅔ .35#	.239	= 559#
6" concrete slab	75#	.239	= 1790#
Concrete coping	2 @ 25#		= 50
Handrail	2 @ 35#		= 70
			3664#
water Contents in flume	80 @ 62#		= 4960
Dead Load metal			2476
			11100#
	For one truss	11100 ÷ 2	= 5550# per lin ft
Live Load	24 . 100	= 2400#	per lin ft
	or	1200#	per lin ft of truss

Design of truss

Span length 120'-0" c to c of End bearings giving space of 3'-8" on pier.
Distance between trusses assumed 13'-6" Depth of truss = 17'3" panel length 10'0"
each end 12 panels.

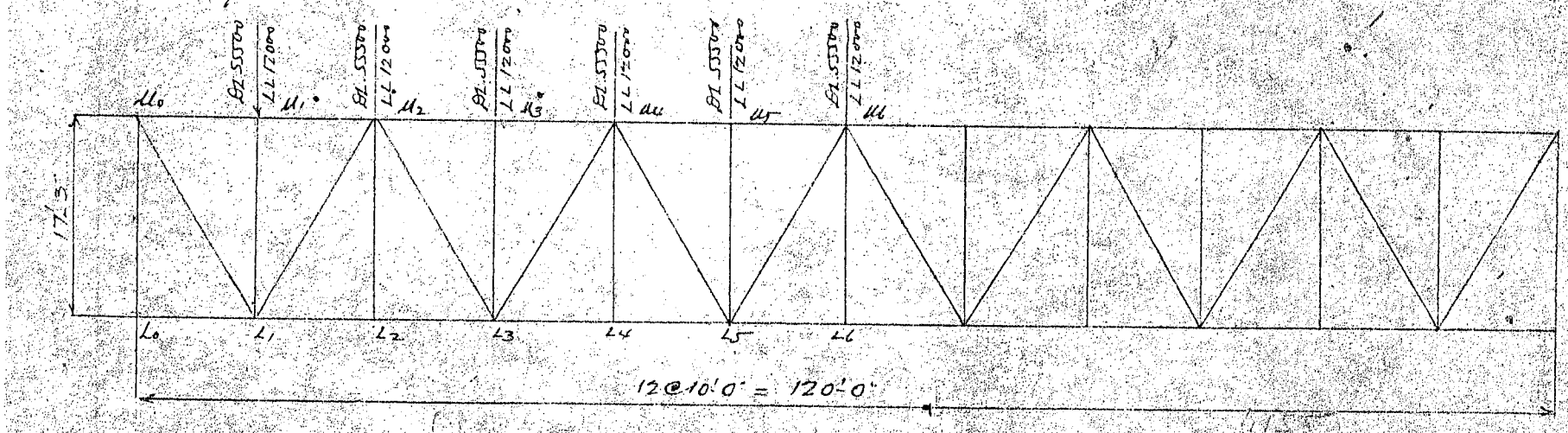
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CALCULATIONS FOR

Dobunkei: Bridge
Design of truss



Dead Load panel Concentration = 5550 . 10 = 55500# $\sec\theta = \frac{19.92}{17.25} = 1.115$ $\tan\theta = \frac{10.0}{17.25} = 0.58$
Live Load panel concentration = 1200 . 10 = 12000#
w sec θ = 55500 . 1.155 = 61900 w tan θ = 55500 . 0.58 = 32200#
w' sec θ = 12000 . 1.155 = 13380 w' tan θ = 12000 . 0.58 = 6960#

	Dead Load Stress				Live Load Stress			
U_0-U_2	32200	. 5.5	= 177100#	C	6960	. 5.5	= 38200	C
L_1-L_3		. 10.0	= 322000	T		. 10.0	= 69600	T
U_2-U_4		. 13.5	= 435000	C		. 13.5	= 93800	C
L_3-L_5		. 16.0	= 515000	T		. 16.0	= 111200	T
U_4-U_6		. 17.5	= 563000	C		. 17.5	= 121800	C
L_5-L_5'		. 18.0	= 579000	T		. 18.0	= 125000	T
U_0-L_1	(61900#	. 5.5	= 341000	T	$\frac{13350}{2}$	. 6.6	= 73600	T
L_1-U_2		. 4.5	= 278500	C		. 5.5	= 63000	C
U_2-L_3		. 3.5	= 217000	T		. 4.5	= 50200	T
L_3-U_4		. 2.5	= 155000	C		. 3.6	= 40100	C
U_4-L_5		. 1.5	= 92850	T		. 2.8	= 31200	T
L_5-U_6		. 0.5	= 30950	C		. 2.1	= 23400	C

Stress in U_0-L_0 DL. 55500 . 6.0 = 333000#
LL. 12000 . 6.0 = 72000
405000#

Stress in Langers U_2-L_2, U_4-L_4 and U_6-L_6
water flume 695#
Bottom Lateral & Sway 84
Trussis Lower half $\frac{1295}{2}$
1427 ÷ 2 = 714#
water in flume 4960 ÷ 2 = 2480#
3194# per ft panel concentration 31940#

Stress in verticals U_1-L_1, U_3-L_3, U_5-L_5
Dead Load 11100#
DL. ½ truss 6248
10452# Panel Concentration 1024520# ÷ 2 = 52260#
Live Load Concentration 12000
64260#

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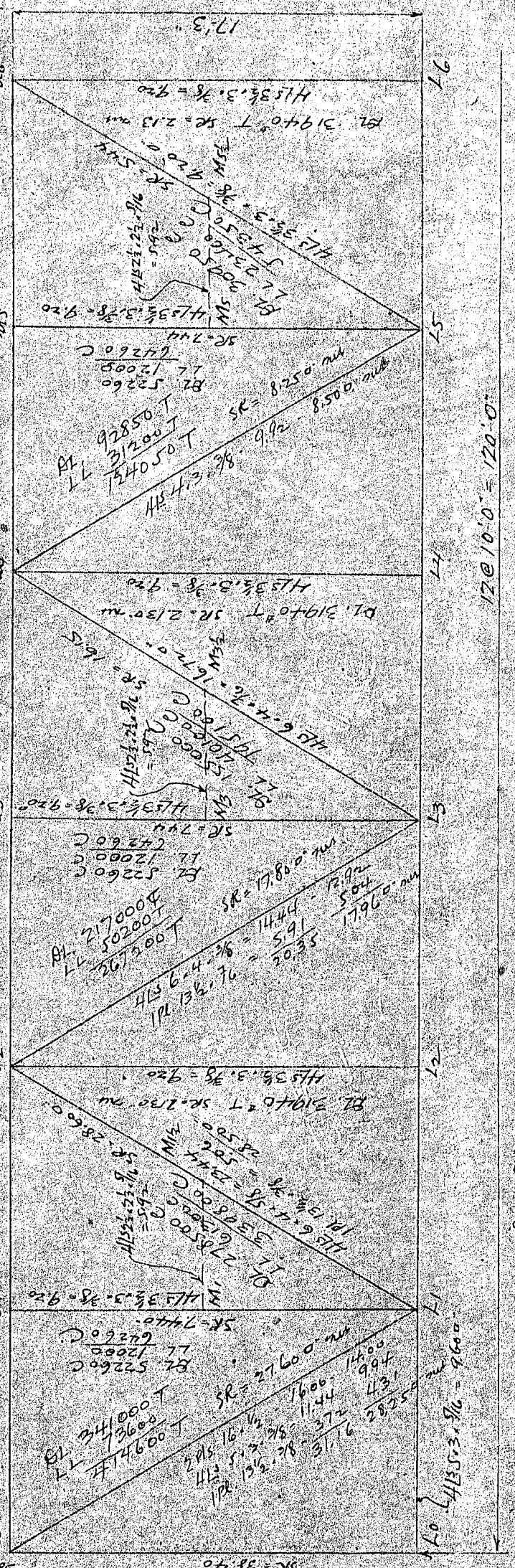
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CALCULATIONS FOR

Dobunkie Bridge

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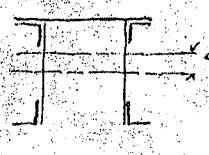
CALCULATIONS FOR

Sobunkei Bridge.
End Post. Stress = 405000 # C

2 webs.	16½ . ⅜	=	12.38	+	281.0	$r = \sqrt{\frac{1119.4}{38.08}} = 5.41$
4 L⁵	4 . 4 . ⅜	=	11.44	. 7.98² + 17.6 =	615.6	
4 L⁵	3½ . 3 . ⅜	=	9.20	. 1.52² + 10.8 =	222.8	Unsupported length say 192"
1 Pl	13½ . ⅜	=	5.06	.	1119.4	$p = 13000 - 70 \times \frac{192}{5.41} = 10520$ #
			38.08 sq in			

Section required = 405000 ÷ 10520 = 38.400 sq in assumed section ok.

Top chord. U_2-U_4



Centre of gravity. Moment of inertia.

1 cov Pl	24 . ½	=	12.00	. 17.25 =	207.0	12.00 . 4.57²		250.5
2 Pls.	17 . ½	=	17.00	. 8.5 =	144.5	17.00 . 4.18²	+ 40.94	= 705.9
2 L⁵	4 . 4 . ⅜	=	5.72	. 15.77 =	90.2	5.72 . 3.09²	+ 8.8	= 83.4
2 L⁵	4 . 4 . ⅜	=	5.72	. 1.23 =	70.5	5.72 . 11.45²	+ 8.8	= 758.8
			40.44 sq in	12.68	512.2			1778.6

$r = \sqrt{\frac{1778.6}{40.44}} = 6.63$ $p = 15000 - 70 \times \frac{120}{6.63} = 13730$ #/sq in
use 13000 #/sq in

Section required = 528800 # ÷ 13000 = 40.60 sq in gross.

Top Chord U_4-U_6. Stress = 684800 ÷ 13000 = 52.5 sq in

1 cov. Pl	24 . ½	=	12.00
2 Pls	17 . ½	=	17.00
4 L⁵	4 . 4 . ½	=	15.00
2 Pls	8½ . ½	=	8.50
			52.50 sq in

Top chord U_6-U_2 215300 ÷ 13000 = 16.50 sq in

2 web pls	17 . ⅜	=	12.75
4 L⁵	4 . 3 . ⅜	=	9.92
			22.67 sq in

Verticals U_1-L_1, U_3-L_3 and U_5-L_5

Try 4 L⁵ 3½ . 3 . ⅜ = 9.20 sq in $r = 1.67$ Unsupported length = 1035"
$P = 13000 - 70 \frac{l}{r} = 8650$ #/sq in. Section required 64260 ÷ 8650 = 7.44 sq in
assumed section ok.

Hangers. U_2-L_2, U_4-L_4 and U_6-L_6.
Stress = 31940 ÷ 15000 = 2.130 sq in nil. Use 4 L⁵ 3½ . 3 . ⅜ = 9.20 sq in

Diagonal L_1-U_2:

						moment of inertia
4 L⁵	6 . 4 . ⅝	=	23.44	.	2.22² + 8.44 =	20.02
1 Pl.	13½ . ⅜	=	5.06	.		
			28.50			

$r = \sqrt{\frac{200.2}{28.5}} = 2.67$ $p = 15000 - 70 \frac{l}{r} = 11880$ #/sq in.
Section required = 339800 ÷ 11880 = 28.60 sq in.
Diagonal L_3-U_4 assume 4 L⁵ 6 . 4 . ⅞ = 16.72 $r = 2.88$ $p = 15000 - 70 \frac{l}{r} = 12100$ #/sq in.
Section required = 195100 ÷ 12100 = 16.15 sq in gross.

Diagonal L_5-U_6 assume 4 L⁵ 3½ . 3 . ⅜ = 9.20 sq in $r = 1.68$ $P = 15000 - 70 \frac{l}{r} = 10000$ #/sq in.
Section required = 54350 ÷ 10000 = 5.44 sq in.
assumed section ok

Submembers. M_1-$M_{1½}$, M_3-$M_{3½}$ and M_5-$M_{5½}$
use 4 L⁵ 2½ . 2½ . ⅝ = 5.92 sq in to divide the unsupported length.

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CALCULATIONS FOR

Sobunkei Bridge

Approximate weight of truss.

Top chord	U_0U_2	22.67	@	3.4 ×	20 =	1540
	U_2U_4	40.44	@	" ×	20 =	2750
	U_4U_6	52.50	@	" ×	20 =	3570
Bottom chord	L_0L_1	9.60	@	" ×	10 =	326
	L_3L_1	27.24	@	" ×	20 =	1850
	L_3L_5	48.00	@	" ×	20 =	3260
	L_5L_5'	53.67	@	" ×	10 =	1820
End post	U_0L_0	38.08	@	" ×	17.1 =	2220
verticals	3 @	9.20	@	" ×	17.25 =	1620
hangers	2½ @	9.20	@	" ×	17.25 =	1350
Diagonals	U_0L_1	31.16	@	" ×	19.92 =	2110
"	L_1U_2	28.50	@	" ×	19.92 =	1930
"	U_2L_3	20.35	@	" ×	19.92 =	1380
"	L_3U_4	16.72	@	" ×	19.92 =	1150
"	U_4L_5	9.92	@	" ×	19.92 =	672
"	L_5U_4	9.20	@	" ×	19.92 =	623
Sub members	3 -	5.92	@	" ×	5.0 =	302

29473 × 2 = 58946

Details say 34% 20000

78946

78946 ÷ 120 = 658# per lin ft.

For one span 1316# per lin ft

assumed wt of truss ok.

weight of one span = say 158000#

Load on pin 405000#

Assume 6" pin. bearing 6 × 22000 = 132000# Thickness of ribs = 405000 ÷ 132000 = 3.07"

use 2 - 1¾" ribs = 3.5" Use 5¼" pin.



Bending moment 202500# × .75 = 152.000 in#

5¼" pin good for bending moment of 312500 in#

Load on shoe say 408000#

diameter of roller 4¾" 500 : 475 = 2375# 408000 ÷ 2375 = 172"

use 7 rollers 172 ÷ 7 = 24.6"

Size of base required 408000 ÷ 400#/□" = 1020 □"

For fixed shoe 27" × 38" = 1027 □"

for roller shoe 40 × 37¾ = 1508 □"

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CALCULATIONS FOR

Sobunkei Bridge
Weight of Truss.
End post Mo-Lo 4 Required

main section	2 Pls.	16½ . 3/8	@	21.04"	=	17'6½"	737.0
	2 Ls	4.4.3/8	@	9.8	=	17'6½"	343.0
	2 Ls	4.4.3/8	@	9.8	=	16'3½"	319.0
	4 Ls	3½.3.3/8	@	7.9	=	17'2½"	544.0
	1 Pl.	13½.3/8	@	17.21"	=	17'2½"	276.0
Die Pls.	4 Pls.	24 × ½	@	4.080	=	1'9"	286.0
fills	2 Pls.	8½ . 3/8	@	10.84	=	2'3"	48.8
pin plo.	2 Pls.	15 . ½	@	25.50	=	1'6"	76.5
fills	2 Pls.	6½ . 3/8	@	8.29	=	1'1"	17.9
gusset pl.	2 Pls.	20 . ½	@	34.00	=	3'5"	164.3
" "	2 Pls.	37½ . ½	@	63.75	=	4'1"	512.0
							3324.5 . 4 = 13298.0

Top chord Mo-M1 4 Required

main section	2 Pls	17 . 3/8	@	21.68	=	18'3¾"	793.0
	2 Ls	4.3.3/8	@	8.5	=	19'6¼"	333.7
	2 Ls	4.3.3/8	@	8.5	=	17'8¾"	301.0
web splice	2 Pls	6 . 3/8	@	7.65	=	0'8½"	10.9
Die Plate	2 Pls	22" . ½"	@	37.40	=	2'0"	149.6
gusset plate	1 Pl.	20 . 3/8	@	25.50	=	2'10½"	73.4
" "	1 Pl.	18 . 3/8	@	22.95	=	2'7⅓	60.4
fills	2 Pls	7½ . ½	@	12.75	=	1'4½	35.0
splice	2 Pls.	8½ . 3/8	@	10.84	=	1'6"	32.5
	2 Pls.	15 . 3/8	@	19.13	=	1'6"	57.4
	2 Pls.	15 . ⅜	@	6.38	=	0'9"	9.6
	4 Pls	3 . ⅜	@	1.275	=	0'9"	3.8
tie pl.	1 Pl.	22" . ½"	@	37.40	=	2'0"	74.8
	1 Pl	22 . ½	@	37.40	=	1'1½"	42.3
splice	2 Ls	4.4.3/8	@	9.8	=	1'6"	29.4
M1 fills	2 Pls	8 3/8	@	10.66	=	0'8½"	15.1
Lacing bars	32	2½ . 7/16	@	3.72	=	2'6"	297.6
	1 Pl.	16 . 3/8	@	20.40	=	2'1"	42.5
							2361.5 . 4 = 9446.0

Top chord M2-M4 4 Required.

	2 Pls	17 . ½	@	28.90	=	18'6¼	1070.0
	4 Ls	4.4.3/8	@	9.8	=	18'6¼"	726.0
	1 Pl	24 . ½	@	40.80	=	19'6¼	796.4
gusset plo.	2 Pls	40 . ½	@	68.00	=	3'9½	515.4
fills	2 Pls	8 3/8 . 3/8	@	10.66	=	0'8½	15.1
"	2 Pls	8 3/8 . 3/8	@	10.66	=	0'8½	15.1
M3	2 Pls	7½ . ½	@	12.75	=	1'4½	35.0
splice	1 Pl	24 . ½	@	40.80	=	2'6"	102.0
	2 Pls	17 . ½	@	28.90	=	2'0"	116.0
"	2 Pls	8½ . ½	@	14.45	=	2'0"	57.8
	4 fill	3 . ⅜	@	1.275	=	1'0"	5.1
tie plo	2 Pls	24 . ½	@	40.80	=	2'0"	163.2
gusset plate	1 Pl.	15 . 3/8	@	19.13	=	3'2½"	61.1
" "	2 Pls.	18 . 3/8	@	22.95	=	2'10"	130.4
splice	1 Pl.	4 . 3/8	@	5.10	=	1'9"	8.9
lacing bars	12	2½ . 7/16	@	3.72	=	2'9"	177.8
							3940.3 . 4 = 15761.0

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MARUNOUCHI, TOKIO

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CALCULATIONS FOR

Sobunkei Bridge.

Top chord U_4-U_6: 2 Required

	2Pls.	17. × ½	@	28.90	. 20'-2½"	=	1170.0
	4Ls	4. 4. × ½	@	17.8	. 20'-2½	=	1034.8
	2Pls.	8½. × ½	@	14.45	. 18'-8"	=	539.6
	1Pl.	24. × ½	@	40.80	. 20'-2½"	=	824.6
Gusset plo.	2Pls.	35. × ½	@	59.50	. 3'-2½"	=	382.0
" "	2Pls.	7½. × ½	@	12.75	. 1'-4½"	=	35.0
Splice	1Pl.	24. × ½	@	40.80	. 3'-6"	=	102.0
"	2Ls	4. 4. × ½	@	12.8	. 2'-0"	=	51.2
"	3Pls.	17. × ½	@	28.90	. 2'-0"	=	116.0
"	1Pl.	24. × ½	@	40.80	. 2'-0"	=	81.6
"	2Pls.	15. × ½	@	25.50	. 2'-0"	=	102.0
"	1Pl.	24. × ½	@	40.80	. 2'-0"	=	81.6
Gusset pls.	2Pls.	18". × ⅜	@	22.95	. 2'-10½"	=	131.5
"	1Pl.	13. × ⅜	@	16.58	. 2'-10½"	=	47.6
Lacing bars	12.	2½ × 7/16	@	3.72	. 2'-9"	=	122.8
							4822.3 × 2 = 9645"

Top chord U_4-U_6: 2 Required

	2Pls.	17. × ½	@	28.90	. 25'-0½"	=	1450.0
	4Ls	4. 4. × ½	@	12.8	. 25'-0½"	=	1282.0
	2Pls.	8½. × ½	@	14.45	. 23'-6"	=	679.2
	1Pl.	24. × ½	@	40.80	. 25'-0½"	=	1021.6
Gusset pls.	2Pls.	35. × ½	@	59.50	. 3'-2½"	=	382.0
" "	2Pls.	7½. × ½	@	12.75	. 1'-4½"	=	35.0
" "	2Pls.	31. × ½	@	52.70	. 2'-9"	=	290.0
Fi plates	2Pls.	24. × ½	@	40.80	. 2'-0"	=	163.2
Gusset plo.	2Pls.	18. × ⅜	@	22.95	. 2'-10½"	=	131.5
	2Pls.	13. × ⅜	@	16.58	. 2'-10½"	=	95.0
Lacing bars	12	7½ × 7/16	@	3.72	. 2'-9"	=	122.8
							5652.3 × 2 = 11305"

Bottom Chord L_0-L_1 4 Required

	4Ls	5 × 3 × 5/16	@	8.2"	. 8'-2½"	=	269.3
Fill.	2Pls.	13½ × ⅜	@	17.21	. 1'-0"	=	34.41
" "	2Pls.	13½ × ⅜	@	17.21	. 0'-9"	=	25.8
Lateral Conn	1L	4 × 3 × 5/16	@	7.2	. 1'-0"	=	7.2
"	1Pl.	16. × 5/16	@	17.0	. 2'-2"	=	36.9
							373.6" × 4 = 1494"

Bottom chord L_1-L_3. 4 Required

	2Pls.	16. × ½	@	27.2	. 17'-0"	=	924.8
	4Ls	5 × 3½ × 7/16	@	12.0	. 18'-0"	=	864.0
Gusset pls.	2Pls.	40. × ½	@	68.0	. 3'-9"	=	510.0
L_1	1Pl.	12. × ⅜	@	15.3	. 2'-3"	=	34.4
	2Ls	4. 4. × 7/16	@	7.2	. 1'-0½"	=	14.7
	1 fill	5½ × 7/16	@	8.18	. 0'-6"	=	4.1
	2 fills	6. × ¼	@	10.2	. 10⅜"	=	17.9
Fi Plates	3 Pls	12. × ⅜	@	15.3	. 0'-9"	=	34.4
L_2	1Pl.	12. × ⅜	@	15.3	. 2'-2"	=	33.2
"	2Ls	4. 3. × 5/16	@	7.2	. 1'-0½"	=	14.7
"	1 fill	5½ × 7/16	@	8.18	. 0'-6⅜"	=	4.3
Splice	2Pls.	16. × ⅝	@	34.0	. 2'-8"	=	181.6
"	4Ls	5 × 3½ × 7/16	@	17.0	. 2'-3"	=	108.0
"	1Pl.	12. × ⅜	@	15.3	. 2'-0"	=	30.6

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CALCULATIONS FOR

Sobunkei - Bridge -

Bottom Chord L1-L3 Continued.

Lateral Conn	1L	5 × 3 × 5/16	@ 8.2	3'7"	=	21.2
	1PL	14 × 7/16	@ 14.88	2'7"	=	38.4
	1L	5 × 3 × 5/16	@ 8.2	3'2"	=	17.7
	1PL	12 × 7/16	@ 12.75	2'3"	=	28.7
						28827 × 4 = 11531

Bottom Chord L3-L5 4 Required

	3Pls	16 × 1/2	@ 27.2	16'11½"	=	922.6
	2Pls	16 × 1/2	@ 27.2	23'1"	=	1255.6
	4Ls	5 × 3½ × 1/2	@ 13.6	23'1"	=	1260.0
Gusset pls	2Pls	36 × 1/2	@ 61.2	3'3½"	=	402.7
Splice L3	2Pls	16 × 1/2	@ 27.2	4'3"	=	231.2
	1PL	12 × 3/8	@ 15.3	2'2"	=	33.2
"	2Ls	4 × 3 × 5/16	@ 7.9	1'0½"	=	14.7
"	1 fill	5½ × 1/2	@ 9.35	0'6"	=	4.7
Ins Pls	4Pls	12 × 3/8	@ 15.2	0'9"	=	46.0
L4	1PL	12 × 3/8	@ 15.3	2'2"	=	33.2
"	2Ls	4 × 3 × 5/16	@ 7.2	1'0½"	=	14.7
"	1 fill	5½ × 1/2	@ 9.35	0'6 3/8"	=	5.0
Lateral Conn	2Ls	5 × 3 × 5/16	@ 8.2	2'2"	=	35.6
"	2Pls	9 × 5/16	@ 9.56	2'2"	=	41.5
						43007 × 4 = 17203

Bottom Chord L5-L5' 2 Required

	2Pls	16 × 1/2	@ 27.2	17'2"	=	934.0
	2Pls	20 × 1/2	@ 27.2	20'0"	=	1088.0
	4Ls	5 × 4 × 1/2	@ 14.5	20'0"	=	1160.0
	1PL	12 × 3/8	@ 15.3	23'0"	=	351.9
Splice	4Pls	16 × 5/8	@ 34.0	6'5"	=	873.2
"	8Ls	5 × 4 × 1/2	@ 14.5	2'10"	=	328.0
Gusset pls	4Pls	36 × 1/2	@ 61.2	2'10½"	=	704.0
"	6Ls	4 × 3 × 5/16	@ 7.2	1'0½"	=	44.0
	3 fills	4½ × 1/2	@ 7.65	0'6 3/8"	=	12.2
	1 fill	7 3/8 × 1/2	@ 17.5	0'3"	=	3.1
Lateral Conn	32Ls	5 × 3 × 5/16	@ 8.2	2'2"	=	534
"	3Pls	9 × 5/16	@ 9.56	2'2"	=	62.4
						56142 × 2 = 11228

Diagonal U0-L1 4 Required

	2Pls	16 × 1/2	@ 27.2	13'6½"	=	736.6
	4Ls	5 × 3 × 3/8	@ 9.8	18'0"	=	705.6
	1web	13½ × 3/8	@ 17.21	18'0"	=	309.8
	4Pls	16 × 5/8	@ 34.0	2'8½"	=	368.6
						2120.6 × 4 = 8482

Diagonal L1-U2 4 Required

	2Ls	6 × 4 × 5/8	@ 20.0	18'3"	=	730.0
	2Ls	6 × 4 × 5/8	@ 20.0	18'0"	=	720.0
	1PL	13½ × 3/8	@ 17.21	18'3"	=	314.0
						1764.0 × 4 = 7056

Diagonal U2-L3 4 Required

	4Ls	6 × 4 × 3/8	@ 12.3	17'9"	=	873.3
	1PL	13½ × 3/8	@ 17.21	17'9"	=	305.5
	2Pls	12½ × 3/8	@ 15.94	1'10½"	=	59.8
	2Pls	12½ × 1/2	@ 21.25	1'0"	=	43.5
						1281.1 × 4 = 5124

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CALCULATIONS FOR

Dobunkei-Bridge

Diagonal L3-U4 4 Required

4Ls	6 × 4 × 7/16	@	14.3	×	17'7"	= 1005.6
2 Pls.	13½ × 3/8	@	17.21	×	1'9"	= 60.2
21 bars	2½ × 3/8	@	3.19	×	1'3½	= 86.5
						1152.3" × 4 = 4609.0

Diagonal U4-L5 4 Required

4Ls	4 × 3 × 3/8	@	8.5	×	17'9"	= 603.5
2Pls.	13½ × 3/8	@	17.21	×	1'9"	= 60.2
21 bars	2½ × 3/8	@	3.19	×	1'3½	= 86.5
						750.2 × 4 = 3001.0"

Diagonal L5-U6 U6 4 Required

4Ls	3½ × 3 × 3/8	@	7.9	×	17'6"	= 553.0
2Pls.	13½ × 3/8	@	17.21	×	1'3"	= 43.0
21 bars	2½ × 3/8	@	3.19	×	1'3½	= 86.5
						682.5 × 4 = 27300"

Vertical U1-L1 4 Required

4Ls	3½ × 3 × 3/8	@	7.9	×	16'3"	= 514.0
1Pl	13½ × 3/8	@	17.21	×	1'3	= 22.0
Lacing bars 15	2½ × 3/8	@	3.19	×	1'3½	= 61.9
1Pl	27¾ × 3/8	@	35.38	×	2'1½	= 75.0
2Ls	4 × 3 × 3/8	@	8.5	×	1'1⅛	= 19.0
2 fills	4 × 3/8	@	5.1	×	0'7⅞	= 7.0
1Pl	13½ × 3/8	@	17.21	×	2'0"	= 34.0
						732.9 × 4 = 2930.8"

Verticals U2-L2, U4-L4 and U6-L6 4 Required each for U2 & U4 2 required for U6

4Ls	3½ × 3 × 3/8	@	7.9	×	17'0½"	= 538.0
1Pl	13½ × 3/8	@	17.21	×	1'8½	= 29.0
Lacing bars 16	2½ × 3/8	@	3.19	×	1'3½	= 66.0
1Pl	27¾ × 3/8	@	35.38	×	2'1½	= 75.0
2Ls	4 × 3 × 3/8	@	8.5	×	1'1⅛	= 19.0
2 fills	4 × 3/8	@	5.1	×	0'7⅞	= 7.0
1Pl	13½ × 3/8	@	17.21	×	2'0"	= 34.0
						768.0 × 10 = 7680"

Verticals U3-L3 and U5-L5 8 Required

4Ls	3½ × 3 × 3/8	@	7.9	×	17'05"	= 538.0
1Pl	13½ × 3/8	@	17.21	×	1'3	= 22.0
Lacing bars 16	2½ × 3/8	@	3.19	×	1'3½	= 66.0
1Pl	27¾ × 3/8	@	35.38	×	2'1½	= 75.0
2Ls	4 × 3 × 3/8	@	8.5	×	1'1⅛	= 18.0
2 fills	4 × 3/8	@	5.1	×	0'7⅞	= 7.0
1Pl	13½ × 3/8	@	17.21	×	2'0"	= 34.0
						761.0 × 8 = 6088"

Submembers M1-M1½ M3-M3½ and M5-M5½ 12 Req'd

2Pls	9 × 9/16	@	9.56	×	1'2"	= 25.0
2Pls	9 × 9/16	@	9.56	×	2'1"	= 40.0
4Ls	5½ × 2½ × 9/16	@	5.00	×	3'1"	= 77.0
2 Pls.	13½ × 9/16	@	14.44	×	0'9"	= 21.0
Lacing bars 3	2½ × 9/16	@	2.39	×	1'3½	= 9.0
						172.0 × 12 = 2064

Weight of truss 150676" not including rivets

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CALCULATIONS FOR

Sobunkei - Bridge.
Top Lateral Bracings.
Panel U_1-U_2 2 Required

2Ls	3·3·3/8	@	7.2	·	6'-9 3/4"	=	98.0
1L	3·3·3/8	@	7.2	·	6'-10 3/4"	=	50.0
1L	3·3·3/8	@	7.2	·	6'-7 3/4"	=	48.0
1L	3·3·3/8	@	7.2	·	14'-4 1/2"	=	104.0
1L	3·3·3/8	@	7.2	·	14'-1 1/2"	=	102.0
1Pl	12·3/8"	@	15.3	·	3'-1"	=	47.0
					449.0	× 2	= 898.0

Panel U_1-U_2 2 Required

2Ls	3·3·3/8	@	7.2	·	14'-1 1/2"	=	203.0
1L	3·3·3/8	@	7.2	·	6'-10 3/4"	=	50.0
1L	3·3·3/8	@	7.2	·	6'-7 3/4"	=	48.0
1L	3·3·3/8	@	7.2	·	6'-9 1/4"	=	49.0
1L	3·3·3/8	@	7.2	·	6'-6 1/4"	=	47.0
1Pl	12·3/8	@	15.3	·	2'-6 1/2"	=	39.0
					436.0	× 2	= 872.0

Panel U_2-U_3 and U_3-U_4 4 Required

1L	5×3·3/8	@	9.8	·	6'-8 3/4"	=	66.0
1L	5·3·3/8	@	9.8	·	6'-9 3/4"	=	67.0
1L	5·3·3/8	@	9.8	·	14'-1 1/2"	=	138.0
2Ls	3·3·3/8	@	7.2	·	0'-8 3/4"	=	11.0
2Ls	3·3·3/8	@	7.2	·	0'-7"	=	8.0
1Pl	8·3/8	@	15.3	·	2'-6"	=	38.0
					328.0	× 4	= 1312.0

Panel U_4-U_5 2 Required

1L	5·3·3/8	@	9.8	·	6'-8 3/4"	=	66.0
1L	5×3·3/8	@	9.8	·	6'-9 3/4"	=	67.0
1L	5·3·3/8	@	9.8	·	14'-1 1/2"	=	138.0
1Pl	8·3/8	@	10.2	·	2'-1"	=	21.0
					292.0	× 2	= 584.0

Panel U_5-U_6 2 Required

1L	3½·2½·3/8	@	7.2	·	7'-0"	=	50.0
1L	3½·2½·3/8	@	7.2	·	7'-0"	=	50.0
1L	3½·2½·3/8	@	7.2	·	14'-1 1/2"	=	102.0
1Pl	6·3/8	@	6.38	·	1'-11"	=	12.0
					214.0	× 2	= 428.0

Weight of Top Lateral Bracing = 4094#

Bottom Lateral Bracings

Panel L_0-L_1 2 Required

1L	4·3·3/8	@	8.5	·	6'-10 1/2"	=	58.0
1L	4·3·3/8	@	8.5	·	7'-3 1/2"	=	62.0
1L	4·3·3/8	@	8.5	·	14'-7 1/2"	=	124.0
1Pl	7·3/8	@	8.93	·	2'-10"	=	25.0
					269.0	× 2	= 538.0

Panel L_1-L_2 2 Required

1L	3½·3·3/8	@	7.9	·	7'-3 1/2"	=	57.0
1L	3½·3·3/8	@	7.9	·	7'-3 1/2"	=	57.0
1L	3½·3·3/8	@	7.9	·	14'-7 1/2"	=	116.0
1Pl	6½·3/8	@	8.29	·	5'-5"	=	20.0
					250.0	× 2	= 500.0

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MARUNOUCHI, TOKIO

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CALCULATIONS FOR

Jotunkei Bridge

Bottom Lateral Bracings Continued

Panel L2-L3, L3-L4, L4-L5 and L5-L6 8 Required

2	L	3½ × 2½ × 3/8	@	7.2	7'4"	= 106.0
1	L	3½ × 2½ × 3/8	@	7.2	14'7½"	= 105.0
1	Pl	6 × 3/8"	@	7.65	2'0"	= 15.0
					226.0 × 8	= 1808.0

Total weight of Bottom Lateral Bracings = 2846#

Sway Bracings under flume.

End Sways 2 Required

2	L	5 × 3 × 3/8	@	9.8	12'2"	= 238.0
2	L	5 × 3 × 3/8	@	9.8	12'0"	= 236.0
4	L	2.5 × 3½ × 3/8	@	7.2	11'5"	= 329.0
2	Pls	15 × 3/8	@	19.13	1'5"	= 54.0
4	L	4 × 3 × 3/8	@	8.5	11'0"	= 374.0
Lacing bars	1	4 × 2½ × 3/8	@	2.87	0'10½"	= 35.0
					926.0 × 2	= 1852.0

Intermediate Sways

	1	L 3½ × 2½ × 3/8	@	7.2	13'9"	= 94
	1	L 3½ × 2½ × 3/8	@	7.2	12'9"	= 92
	2	Pls 10½ × 3/8	@	13.39	1'1	= 29
	4	L 4 × 3 × 3/8	@	8.5	0'6"	= 17
	2	L 4 × 3 × 3/8	@	8.5	12'4"	= 210
					442.0 × 11	= 4842.0

Total weight of Sway bracings = 6694#

Stringers

	24	I 10" × 3½	@	235#	9'11"	= 5609.0
	96	L 4 × 3 × 3/8	@	8.5	0'7½"	= 509.0
	48	Pls 6½ × 3/8	@	8.29	0'4¾	= 159.0
	24	I 10" × 5"	@	29.99	9'10"	= 7075.0
	96	L 5 × 3 × 3/8	@	9.8	0'7½"	= 592.0
	48	fills 6½ × 3/8	@	8.29	0'4¾	= 159.0
	36	I 12" × 5"	@	31.99	9'10"	= 11321.0
	144	L 5 × 3 × 3/8	@	9.8	0'8½"	= 1002.0
	72	Pls 6½ × 3/8	@	8.29	0'6"	= 299.0
						26725.0#

Total weight of stringers = 26725.0

Floor Beams

End floor Beams 2 Required

Cantilever	4	L 3 × 3 × 3/8	@	7.2	2'7"	= 132.0
	4	L 3 × 3 × 3/8	@	7.2	5'0"	= 144.0
	2	Pls 20½ × 3/8	@	26.14	4'9¾	= 251.0
	4	L 4 × 3 × 3/8	@	8.5	1'5"	= 48.0
Floor beam	2	L 3 × 3 × 3/8	@	7.2	11'8"	= 168.0
	2	L 3 × 3 × 3/8	@	7.2	12'1½	= 175.0
	1	Pl 17 × 3/8	@	21.68	12'1½"	= 263.0
	4	L 4 × 3 × 3/8	@	8.5	1'4¼	= 46.0
	4	L 3 × 3 × 3/8	@	8.5	1'1½	= 38.0
Tension plo.	2	Pls 7½ × 5/8	@	15.94	4'6"	= 144.0
					1409.0 × 2	= 2818.0

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

JIUN MASUDA
CONSULTING ENGINEER
MARUNOUCHI, TOKIO

MADE BY J. M. DATE 15-3-27 FILE NO.
CHECKED BY DATE PAGE NO. 22

CALCULATIONS FOR

Sobunkei-Bridge.

Intermidiate floor Beams 11 Required

Cant.	4Ls	3.3.3/8	@ 7.2	× 4'6"	=	130.0	
	4Ls	3.3.3/8	@ 7.2	× 5'1½"	=	148.0	
	2Pls	20½.3/8	@ 36.14	× 11'9"	=	248.0	
	4Ls	4.3.3/8	@ 8.5	× 11'4¾"	=	48.0	
	2Pls	6½.3/8	@ 8.29	× 0'4"	=	5.0	
Floor Bam	2Ls	3.3.3/8	@ 7.2	× 11'6"	=	166.0	
	6Ls	3.3.3/8	@ 7.2	× 12'1½"	=	175.0	
	1Pl	17.3/8	@ 21.68	× 12'1½"	=	263.0	
	4Ls	4.3.3/8	@ 8.5	× 1'3⅜"	=	45.0	
	4Ls	4.3.3/8	@ 8.5	× 1'1⅝"	=	39.0	
	2Pls	4.3/8	@ 5.10	× 0'4"	=	3.0	
	2Pls	7½.5/8	@ 15.94	× 4'6"	=	1270.0 × 11 =	15554

Total weight of water floor beams = 2 18372#

water flume

	8Pls	60.3/8	@ 76.5	× 11'7"	=	7087.0	
	2Pls	67.3/8	@ 85.4	× 11'7"	=	1978.0	
	20Pls	60.3/8	@ 76.5	× 20'0"	=	30600.0	
	5Pls	67.3/8	@ 85.4	× 20'0"	=	8540.0	
Splice	26Pls	5½.3/8	@ 6.69	× 12'6"	=	2174.0	
at Exp.	2Ls	3.3.3/8	@ 7.2	× 12'6"	=	180.0	
	2Pls	12.3/8	@ 15.3	× 12'6"	=	383.0	
							50942.0
Side beams B1	24Ls	4.3.3/8	@ 8.5	× 9'11"	=	2024.0	
	96Ls	4.3.3/8	@ 8.5	× 0'2½"	=	172.0	
	4Ls	4.3.3/8	@ 8.5	× 1'4"	=	45.0	
	8Ls	4.3.3/8	@ 8.5	× 0'1½"	=	14.0	
B2 B3	48Ls	6.2½ @	12.04	× 9'11"	=	5733.0	
	96Ls	3.3.3/8	@ 7.2	× 0'5"	=	290.0	
	8Ls	6.2½ @	12.04	× 1'4"	=	128.0	
	8Ls	3.3.3/8	@ 7.2	× 0'5"	=	24.0	
B4	8Is	7".4"	@ 16.00	× 11'4"	=	1450.0	
	20Is	7".4"	@ 16.00	× 20'0"	=	6400.0	
Splice	48Pls	5.3/8	@ 6.38	× 0'6"	=	153.0	
							16433.0
Side Uprights	26Is	8".5"	@ 28.02	× 8'8¾"	=	6360.0	
	52Ls	6.3½.3/8	@ 11.7	× 0'2.6"	=	304.0	
	52Ls	3.3.3/8	@ 7.2	× 0'2.8"	=	251.0	
							6915.0

End Floor Beams 2 Required

	2Ls	4.3.3/8	@ 8.5	× 12'5¼"	=	211.0	
	3Ls	4.3.3/8	@ 8.5	× 12'2½"	=	207.0	
	1Pl	18.3/8	@ 22.95	× 9'9"	=	224.0	
	4Pls	6.3/8	@ 7.65	× 1'0"	=	31.0	
	2Pls	14.3/8	@ 17.85	× 2'3"	=	80.0	
	4Ls	4.3.3/8	@ 8.5	× 2'0"	=	68.0	
						821.0 × 2 =	1642.0

Int. Floor Beams 11 Required

	4Ls	4.3.3/8	@ 8.5	× 12'4"	=	419	
	1Pl	18.3/8	@ 22.95	× 10'0"	=	730	
	4Pls	6.3/8	@ 7.65	× 1'0"	=	31	
						680 × 11 =	7480.0

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

JIUN MASUDA
CONSULTING ENGINEER
MARUNOUCHI, TOKIO

MADE BY J. Masuda DATE 5-3-27 FILE NO
CHECKED BY DATE PAGE NO 23

CALCULATIONS FOR

Sobunkei Bridge.

Summary for water flume and other details = 8341.2 #

Weight of Shoe.

Roller shoe 2 Required

2 Pair Pls	15 · ½	@	25.5	· 2'3"	=	115.0
2 " "	10⅞ · ¾	@	27.09	· 2'3"	=	122.0
2 " "	10⅞ · ½	@	18.56	· 2'3"	=	84.0
2Ls	6 · 4 · ½	@	16.2	· 2'3"	=	73.0
2Ls	6 · 6 · ½	@	19.6	· 2'3"	=	88.0
Stiff 2Ls	6 · 4 · ⅜	@	12.3	· 1'2½	=	30.0
Cover 4Ls	4 · 4 · ⅜	@	0.53/4	@ 9.8#	=	19.0
1Pl	27 · 1¼"	@	114.75	· 2'3"	=	258.0
1Pl.	1⅞ · ¼	@	1.60	· 2'3	=	4.0
Dust guard 2Pls.	5¾ · 5/16	@	6.11	· 2'3"	=	28.0
Tapped bolts	10 - 5/16	@	.761	· 0'1"	=	0.2
Rollers	7 - 4¾"	@	60.25	· 2'2"	=	915.0
	4Pls. 1¾ · ½	@	2.98	· 2'0"	=	24.0
Pin	16 - ¾"ø	@	1.502	· 0'1⅓"	=	3.0
Tapped bolts	12 - ¾"ø	@	1.502	· 0'1½"	=	2.0
bolts	2Ls 6 · 4¼ · ⅜	@	14.9	· 2'3"	=	66.0
	1Pl. 1⅞ · ¼	@	1.60	· 2'3"	=	4.0
Bed plate	1Pl. 27 · 1¼	@	114.75	· 3'1¾	=	361.0
				2196.0 · 2	=	4392.0 #

Fixed shoe 2 Required

2Pls.	22 · ½	@	37.40	· 2'3"	=	168.0
2Pls.	16⅝ · ¾	@	42.33	· 2'3"	=	190.0
2Pls.	16⅝ · ½	@	28.72	· 2'3"	=	129.0
4Ls	6 · 6 · ½	@	19.60	· 2'3"	=	176.0
16Ls	5 · 3½ · ⅜	@	10.40	· 0'11¾	=	163.0
1Pl	11¾ · ⅜	@	14.98	· 1'2"	=	18.0
4 fills	6 · ½	@	10.20	· 0'7½"	=	26.0
8 fills	3½ · ½	@	5.95	· 0'6"	=	24.0
1Pl.	27 · 1¼	@	114.75	· 3'1¾	=	361.0
				1253.0 · 2	=	2506.0 #

Pins 4 Required

1 -	5¼"ø	@	73.60	· 1'10¾	=	140.0
2	Nut units					12.0
				152.0 · 4	=	608.0

Anchor bolts 16 Required

1 -	1½"ø	@	6.008	· 2'6"	=	15.0
1Pl	6 · ⅜	@	7.65	· 0'6"	=	4.0
				19.0 · 16	=	304.0

Summary for shoes, pins and anchor bolts = 7810 #

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

JIUN MASUDA
CONSULTING ENGINEER
MARUNOUCHI, TOKIO

MADE BY J.M DATE 15-3-28 FILE NO
CHECKED BY DATE PAGE NO 24

ALCULATIONS FOR

Johnkei-Bridge.

Weight of Handrail

Top rails	4 Ls	3-1½	@	5.27	11'-9"	=	248
	20 Ls	3-1½	@	5.27	10'-0"	=	1054
	22 P/s	3-¾	@	2.55	0'-4"	=	19
Bottom rail	4 Ls	3-1½	@	5.27	1'-9"	=	37
	24 Ls	3-1½	@	5.27	9'-11½"	=	1261
	52 Ls	2-2-¼	@	3.19	0'-2"	=	28
Upright	128 bars	2-⅜	@	2.55	2'-8"	=	871
	340 bars	1½-⅜	@	1.91	2'-1"	=	1350
Segment	442 bars	1½-¼	@	1.275	1'-0"	=	563
Ring	48 bars	1½-¼	@	1.275	1'-6"	=	92
Floor	4 bars	2-⅜	@	2.55	1'-2½"	=	12
	24 bars	2-⅜	@	2.55	1'-2½"	=	24
	48 bars	2-⅜	@	2.55	4'-2½"	=	515
Post	26 Ls	3-3	@	8.50	4'-1¾"	=	915
	104 Ls	2-2-¼	@	3.19	0'-5"	=	55
	26 bars	3-⅜	@	3.83	1'-6"	=	140
Chain	96 Ls	2-2-¼	@	3.19	0'-2"	=	51
	24 P/s	2-⅜	@	2.55	0'-5½"	=	28
							7327 # per span

Summary for Structural Steel in one span

Stringers	26725.0 #
Floor Beams	18372.0
Top Lateals	4694.0
Bottom Lateals	2846.0
Sway framing	6694.0
Plates & other details	83412.0
Trusses	150676.0
Floor	7822.0
Handrails	7322.0
	307951.0 # or 153.975 tons per span

For 9 spans @ 153.975 tons = 1385775 # tons
not including rivets

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（独立行政法人 土木研究所蔵）

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